Assessing Vaccination Coverage Levels Using Clustered Lot Quality Assurance Sampling

Field Manual

VERSION EDITED FOR THE GLOBAL POLIO ERADICATION INITIATIVE (GPEI)

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Executive Summary (Quick Guide to LQAS)

This manual: what it is and who it is for

This field manual is intended for national and local-level officers involved in polio vaccination activities in the framework of the Global Polio Eradication Initiative. It is an operational tool that will help users to make decisions about whether, where and how to conduct a clustered-LQAS survey to evaluate oral polio vaccine (OPV) coverage.

For programmatic and feasibility reasons, the manual is based on a fixed sample size of 60 children, divided into six clusters of ten, which allows lots to be classified according to three bands of coverage: High, Medium, and Low.

What is LQAS?

Lot Quality Assurance Sampling (LQAS) is a rapid survey method to assess the quality of vaccination coverage following supplementary immunization activities (SIA) in pre-defined areas such as a health district (known as "lots"), using a small sample size.

Lot definition

Lot should be defined, based on geographical or administrative boundaries, usually at district or sub-district level, where there is a responsible officer present and accountable for corrective actions.

Sampling methodology

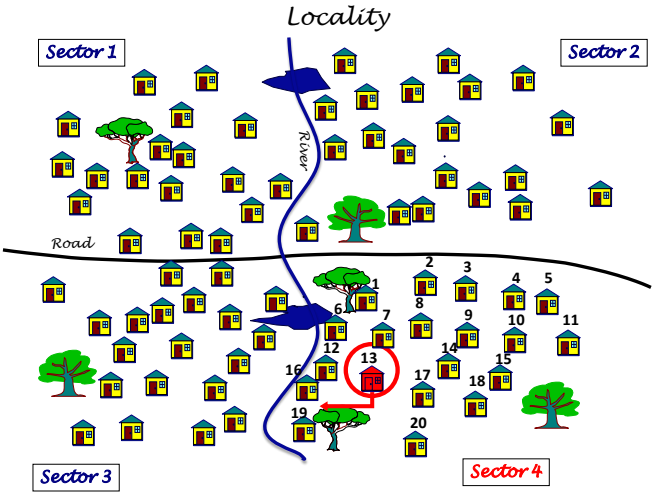
In each lot, 60 children will be sampled in six different clusters, each of 10 children (e.g., villages, settlements).

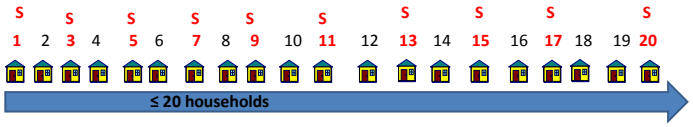
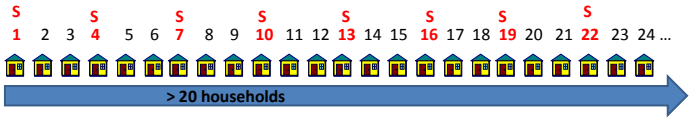
Cluster selection

In each lot, six clusters should be selected, based on PPS (Probability Proportionate to the Size) methodology (i.e., if a village has a larger population, it is more likely to be selected).

House selection

In each cluster, 10 houses with eligible children should be selected, with the following methodology:

1) Divide the locality in four sectors using an available map, or sketch one identifying some landmarks (e.g. road, river, school, mosque, church, etc.).	
2) Select one sector randomly and go to the selected sector.	
3) If the sector has maximum 20 households (HHs), number them and select one randomly as the starting point of the survey.	
4) If the sector has more than 20 HHs, repeat steps 1-3 until a sector with maximum 20 HHs is obtained.	
5) Administer the survey in the HH selected as the starting point.	
6) Once the survey is completed in the selected HH, turn right exiting the house and	

select the following HHs to survey according to the predetermined sampling interval.	*Interval Between Households* Leave 1 household in the sectors of low density with 20 households or less (e.g. Rural areas):  Leave 2 households in the areas of high density with more than 20 households (e.g. Urban areas): 
7) Complete the survey of 10 individuals in the selected cluster and move to the following cluster.	

Child selection

Only one child should be selected in each house:

1. Ask the head of the household or a caregiver how many eligible individuals are present in the house.
2. List them and select one randomly to administer the questionnaire.
3. Once the questionnaire is administered move to the following household according to the sampling interval.

Questionnaire administration

1. Fill out questions regarding the cluster location when you arrive in the locality.
2. The most important question is if the individual selected is vaccinated (the child has the “finger mark”).
3. You may want to add other questions to the questionnaire depending on the survey needs.
4. Always allow for a “comments section” in the questionnaire to specify if there were any issues with selecting households – this will be important for evaluating the ease of the survey procedure for future applications.

Interpreting the results

The recent GPEI informal consultation on monitoring (February 2012) recommended the following interpretation framework:

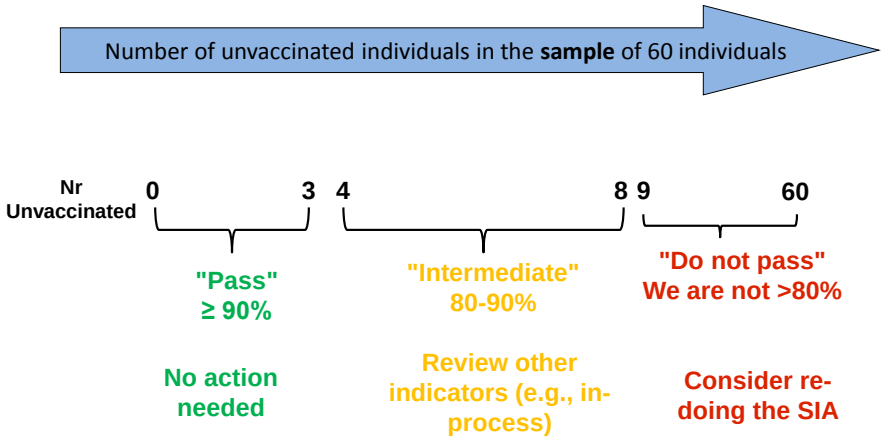
a) 0-3 unvaccinated (out of 60): coverage is the Higher Band (i.e. above 90%) → **PASS** (Maintain the current coverage);

b) 4-8 unvaccinated (out of 60): coverage is probably in the Medium Band (i.e. between 80 and 90%)→ **WARNING**: review other indicators, for example in-process monitoring or administrative coverage in order to decide how to increase coverage levels above 90% in the lot;

c) 9 or more unvaccinated (out of 60): coverage is in the Lower Band (i.e. lack of evidence that it is above 80%) → **FAIL**: consider re-doing the SIA.

Interpretation Framework

Sample = 60 (6 clusters of 10)



If too many lots are "failed", the programme can use additional thresholds (d=19) to identify lots with the "lowest" coverage (i.e. lack of evidence that it is above 60%) and others (i.e. above 60%).

Ensuring quality of the survey

The key to obtaining reliable results is the quality of survey. The supervisor should train surveyors and monitor the activity, especially to ensure (1) that the cluster is selected based on the PPS; (2) the households are selected randomly based on the methodology; and (3) only one child is selected in each house.

Communicating results and taking action

Especially if we are in the FAIL or WARNING bands, it is very important to forward this information immediately to decision-makers and interested stakeholders so that measures to raise vaccination coverage can be rapidly implemented at lot level. **Users** will need to consider what may have caused the low coverage identified in the rejected lots (e.g. absence of immunization cards rather than vaccine, not enough vaccine vials in that area, presence of hard-to reach areas, etc.) and then design solutions.

What if the lot passes?

Clustered-LQAS may also show that vaccination coverage is higher than expected in certain lots, meaning that the classification is: PASS. If the lots thought to have low coverage are actually doing well, users may want to consider redirecting resources to areas more in need. This decision needs to be taken carefully, however, making sure that we do not remove workforce from areas that still need it.

Limitations of LQAS

When the outcome of LQAS is discussed and used to make programmatic decisions, the following limitations should be noted.

1. *There is some risk of misclassification*
   Due to the relatively small sample size and clustering approach, there is a chance of misclassification. In fact in lots where coverage varies greatly between the six clusters, the statistical errors (i.e. alpha and beta error) can be very high (up to 20%). The use of multiple bands for classification may further increase the error of misclassification of lots.

2. *LQAS may not reflect the coverage of entire lots*
   Especially, if the lot is too large and heterogenic in coverage, the outcome of LQAS may not be applicable to the entire lot (e.g., districts).

3. *LQAS does not provide an exact coverage estimate*
   LQAS provide a classification of SIA quality, but it does not give us the point estimate of coverage.

4. *LQAS is a household-based survey*
   LQAS reflects the coverage level of children who are at home at the time of the survey.

Chapter I – LQAS within GPEI

Use of LQAS within the Global Polio Eradication Initiative (GPEI)

For programmatic reasons, the main body of this manual focuses on the approach used to classify lots according to oral polio vaccination (OPV) coverage following Supplementary Immunization Activities (SIA) in countries targeted by the Global Polio Eradication Initiative (GPEI).

The LQAS classification is based on a *decision value (d)*, which is the maximum allowed number of unvaccinated individuals in the lot to classify it as having reached a certain vaccination coverage threshold. For programmatic reasons, with GPEI we use two decision values (d) in order to classify lots according to three bands of vaccination coverage: *High, Medium and Low.*

In this sense LQAS can help *to assess the quality of supplementary immunization activity (SIAs) in the polio-infected or high-risk areas to implement corrective actions (e.g. mopping-up) in the areas of weak coverage identified.*

Importance of immunization quality assurance

The importance of developing a tool for quality assurance stems from recognition of the large investment in manpower needed to run polio vaccination activities and the desire to identify and target low-coverage areas. In this context, LQAS was developed to assess quickly the performance of vaccination campaigns at local level (e.g. health district, local government area, union council, ward, etc.).

Table I.1 What you will get and not get from LQAS

What LQAS will provide	**What LQAS will *not* provide**
Classification of areas (lots) in terms of pre-defined vaccination coverage levels.	Estimation of vaccination coverage at lot level.
Information to decide whether mop-up vaccination is needed.	Information about factors associated with coverage (e.g. reasons for non-vaccination).

LQAS, Independent Monitoring (IM) and EPI cluster surveys

Although the Independent Monitoring (IM) and EPI cluster-sampling methodologies are not the subject of this manual, they share some similarities and objectives with LQAS. It is worth comparing these three methodologies so that readers can have a better understanding of what to expect from a LQAS survey.

LQAS and IM can both be used to monitor vaccination activities with different objectives. LQAS, based on probability (i.e. random) sampling, is a tool to assess the quality of coverage in order to take corrective actions. On the other hand, IM, based on targeted (i.e. not random) sampling, provides a quick validity check on multiple indicators (not only vaccination status, but also social indicators, reasons for non-vaccination, etc.) to help direct vaccination activities.

Finally the EPI cluster survey methodology, based on a much larger cluster-sample, should be used if users want to estimate vaccination coverage with a 95% confidence interval rather than having the classification obtained with LQAS[1].

Table I.2 Comparison of LQAS, IM and EPI cluster sampling

Methodology	Objectives	Advantages	Disadvantages
Lot quality assurance sampling.	To provide information on whether vaccination coverage is adequate or inadequate.	-Small sample sizes are generally used. -Useful for monitoring performance. - Fairly rapid to conduct. - Provides action-oriented information. -Results are interpretable statistically when sample is drawn randomly.	- Follows a strict probabilistic methodology that is complicated to implement. - Less familiar for users in the field. - Demands more resources than IM devoted to sampling in the field. - Does not determine actual coverage at lot level.
Independent Monitoring.	To provide information on multiple indicators that can be used to guide improvements to reach more children by enabling corrective action both during SIAs and in planning for the next rounds.	- Based on targeted sampling. - Rapid, inexpensive, easy to implement. - More familiar for users in the field. - Provides rapid feedback for local decision-making on multiple indicators in "problem" areas (coverage, reasons for non-vaccination, social indicators).	- Results cannot be interpreted statistically. -Does not provide a statistically reliable estimation of coverage (e.g. with a 95% confidence interval), but rather a quick validity check. - Cannot be generalized outside of the area where implemented. - Less useful in areas where coverage is consistently low (i.e. it tends to over-state coverage).
EPI cluster survey.	To estimate vaccination coverage.	- Provides an estimate of vaccination coverage with 95% confidence interval. - Useful for post-campaign evaluation purposes. - Results are	- Follows a strict probabilistic methodology based on cluster sampling that is more complicated to implement. -Sample size is much larger than LQAS

[1] Users interested in IM or EPI cluster sampling are referred to the specific guidelines/manuals:

- "GLOBAL GUIDELINES on Independent Monitoring of Polio Supplementary Immunization Activities (SIA)" available from the Global Polio Eradication Initiative
- "Immunization Coverage Cluster Survey – Reference Manual" available from the World Health Organization

		interpretable statistically. - More familiar for users than LQAS.	(normally at least 30 clusters are needed).

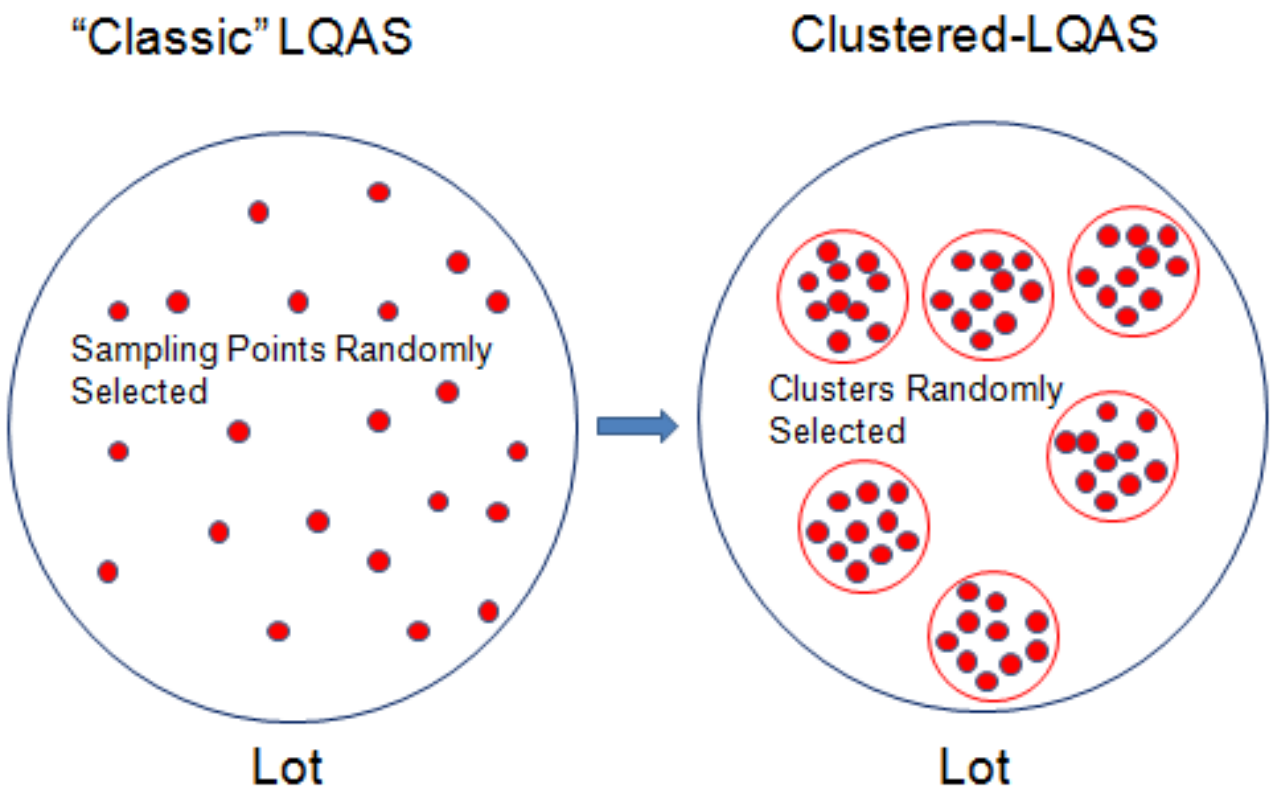
Clustered-LQAS

Traditionally, LQAS has been proposed with a simple random sample design. This means that, if the sample size required to perform the assessment is N=60, then 60 individuals need to be sampled completely randomly in the lot. However, if a lot is large geographical area sampling 60 individuals completely randomly would require considerable time and resources and make the assessment unpractical.

To increase the practicality and rapidity of the assessment, Clustered Lot Quality Assurance Sampling (Clustered-LQAS) has been developed which divides the sample (N) into smaller clusters (k) of n individuals each.

For example, if N=60, k=6, n=10, we would need to select six villages randomly in the health district, and in each village select ten individuals randomly, instead of conducting up to 60 trips in 60 different locations.

Figure I.1 "Classic" LQAS and Clustered-LQAS



Logically, this would increase the rapidity of the assessment. However, there is a decrease in precision, especially if coverage between the clusters is very heterogeneous.

NB: The clustered-LQAS classification is relevant to the complete lot sample (N) and not to the cluster (n). In other words, if a lot is rejected, corrective actions will have to be taken for the entire lot (e.g. the district) and not the location from which the cluster was drawn (e.g. the village in a district).

Table I.3 Advantages and disadvantages of the 6x10 Clustered-LQAS compared to "classic" LQAS

Advantages	Disadvantages
Increased rapidity and feasibility in the field.	Loss of precision if coverage in the lot is not homogeneous (i.e. there is a great variation of coverage between the six clusters in the lot).
Possibility to assess larger lots because less travel is involved (only six locations).	It is not possible to classify the clusters in terms of vaccination coverage, but the classification can only apply to the whole lot.

Chapter II – Implementation of a Clustered-LQAS Survey

Overview

This chapter will guide you through the two phases of implementation of a clustered-LQAS survey:

1. Planning the survey.
2. Conducting the survey.

Phase I – Planning the survey

Objective

The objective of a clustered-LQAS survey at GPEI is to determine whether the vaccination programme has achieved the desired level of performance in a given area (lot) in order to take *corrective measures* if needed.

Lot definition

The lot is our area of intervention. If a lot is rejected by the LQAS rule then we will implement control measures (mop-up vaccination) at this level. Hence, the definition of a lot depends on the programme needs and at what level it is practical to intervene, and is generally based on the administrative level in which the action can be taken.

For demonstration purposes, in this manual we refer to a health district as a lot.
Lots can be defined as smaller or larger areas, depending on circumstances. Here are two examples:

1. In Nigeria, the territory is divided administratively into States, then Local Government Areas (LGAs), and finally into Wards. In this example, LGAs have been proposed as lots, and Wards could also be considered as such.
2. In Pakistan, the territory is divided administratively into Provinces, then Districts, and finally into Union Councils (UCs). In this case, UCs have been proposed as lots.

   These examples are illustrated in Figures II.1 and II.2

Figure II.1 Example of Clustered-LQAS sampling frame proposed in Nigeria

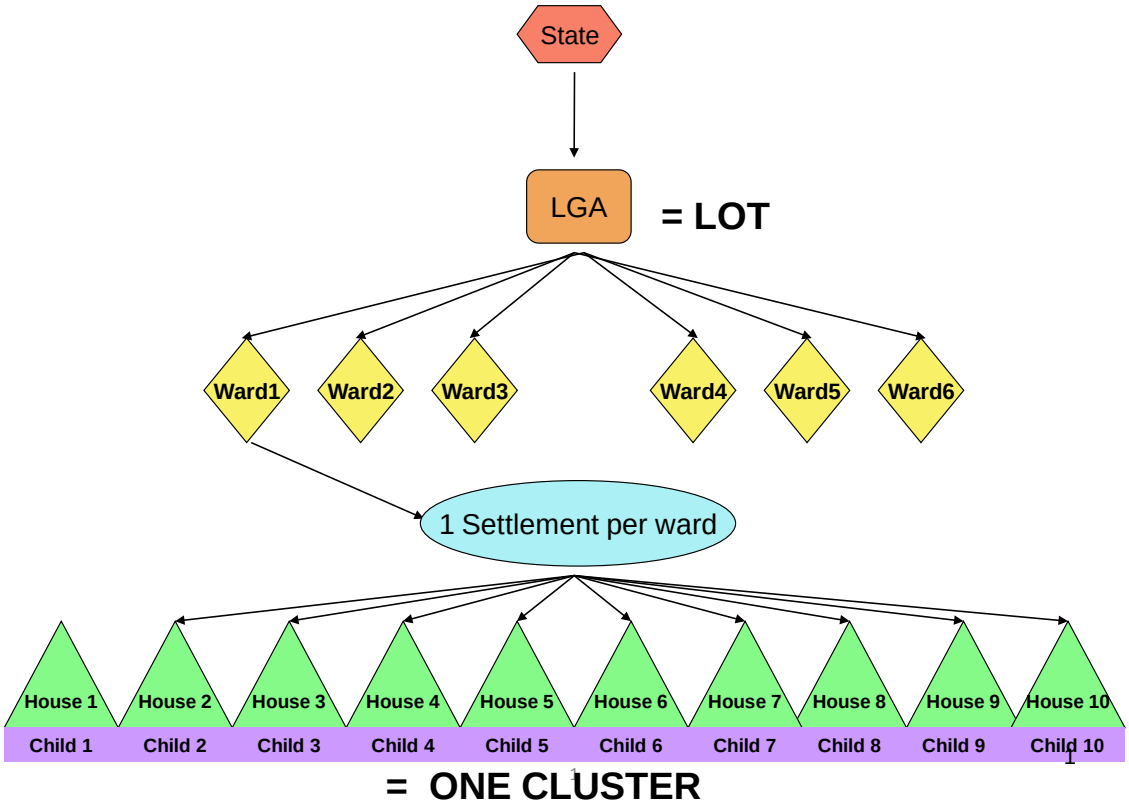
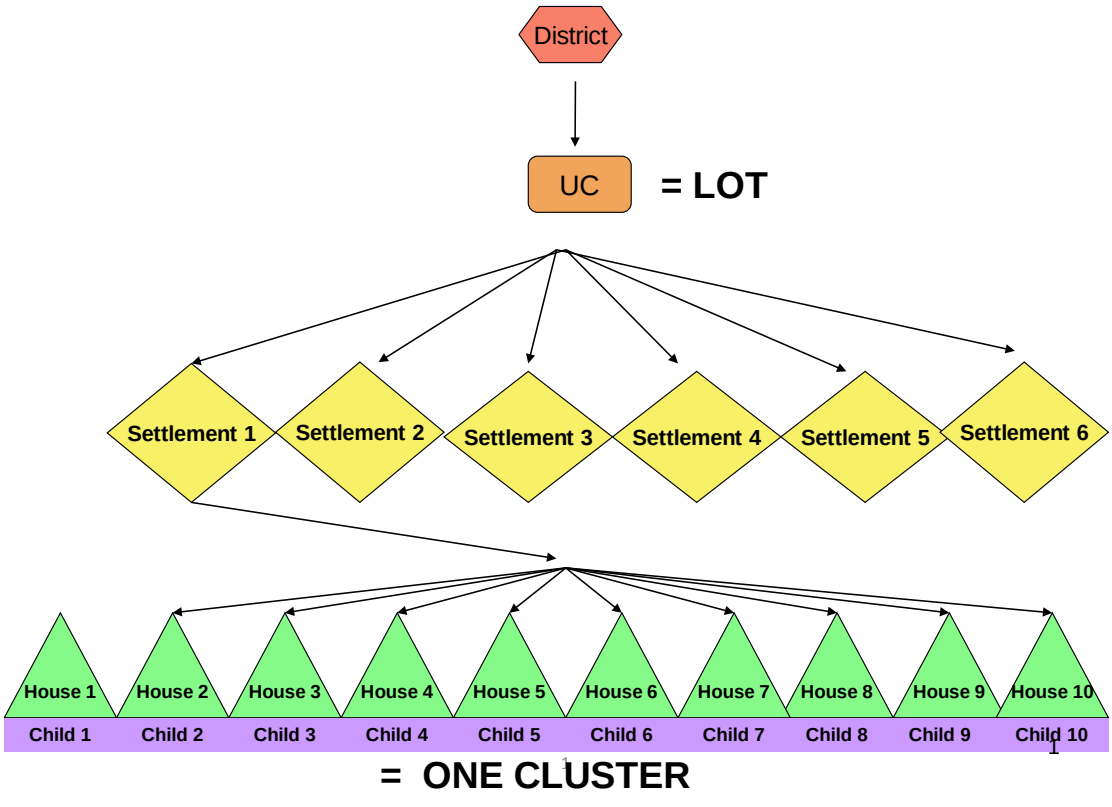


Figure II.2 Example of Clustered-LQAS sampling frame proposed in Pakistan



What to consider when defining the lots:

1) *Size of the lots* (i.e. consider at what level you want/can implement control measures)
   a) *If the lots are large* **(**e.g. LGAs with a total population larger than 100 000), it may not be feasible to implement control measures. Furthermore, the bigger the lot is, the higher the chance will be of high heterogeneity of vaccination coverage in the area (see point 2 below).
   b) *If the lots are small* (e.g. the area covered by one health centre with a total population of between 3 000 - 5 000), the control measures may be too localized to have an impact on the vaccination programme. In addition, significant resources to cover all areas of interest would be required.

2) *Homogeneity in terms of vaccination coverage* (i.e. select a territory where the likelihood of being vaccinated is similar across the different areas) [2]
   a) Consider choosing areas covered by one vaccination team/supervisor as part of the same lot.
   b) Consider separating densely-populated areas and scarcely-populated areas into different lots.
   c) Consider separating rural and urban areas into different lots.

Cluster definition

In the clustered-LQAS approach described in this manual, the sample for each lot is divided into smaller clusters (k) from which a predetermined number of individuals (n) will be sampled. Depending on the definition of a lot, the cluster could be obtained from the lowest administrative division present that allows individuals to be selected. Normally the clusters can be defined as the localities with clear administrative boundaries present in the lot. For example, clusters can be the villages or catchment areas in a health district. In order to select the clusters, you will need to have a list of all these administrative localities in your lot, ideally with census information.

Selection of lots

One way to select the areas at risk is to perform a risk assessment using the information available (e.g. reports from previous campaigns). In the GPEI context, the areas generally selected as lots are:

- Polio-infected areas (e.g. areas with reported polio cases in the previous six months)
- Other areas defined as high-risk by the local programme.

Timing of the survey

In the GPEI context, we recommend that clustered-LQAS surveys be conducted a few days (less than one week) after the completion of the specific round to be assessed, and that the survey be completed within a day or two.

Target population

In the context of evaluating polio SIAs, the target population will be the same one targeted by the SIA:

- Children below five years of age (0-59 months) living in the area defined as the lot during the campaign.

NB: in case the vaccination campaign targets different age groups you may want to consider surveying this age group also with the LQAS survey.

Ascertaining vaccination status (definition of "failure")

During polio SIAs an indelible mark is put on the finger-nail of every child vaccinated with OPV.

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[2] This is because in the clustered-LQAS approach we are selecting clusters in the lot assuming that they will be representative of the entire lot. In other words we do not expect the coverage in the clusters to vary greatly from the mean coverage in the lot (ideally the Standard Deviation should not exceed 0.1).

*Any child who does not have the "finger mark" should be considered as "not vaccinated"***.** Verbal history should not be considered

Recommended interpretation framework

The approach recommended by the GPEI to assess the quality of OPV coverage is based on a "band approach" that allows us to classify lots in three bands (High, Medium, and Low coverage) using two decision values (d) in a sample (N) of 60 divided into six clusters of 10 children.

The GPEI acknowledges that coverage levels of at least 90% are probably necessary to stop polio transmission, but also recognizes that having only one threshold (90%) with one decision value does not provide information on how far the lot is from this coverage target. Hence, the recommended interpretation framework allows us to classify the lots, loosely based on two levels of coverage (90% and 80%) and on two consequent decision values (3 and 8) using a sample of 60 (6x10).

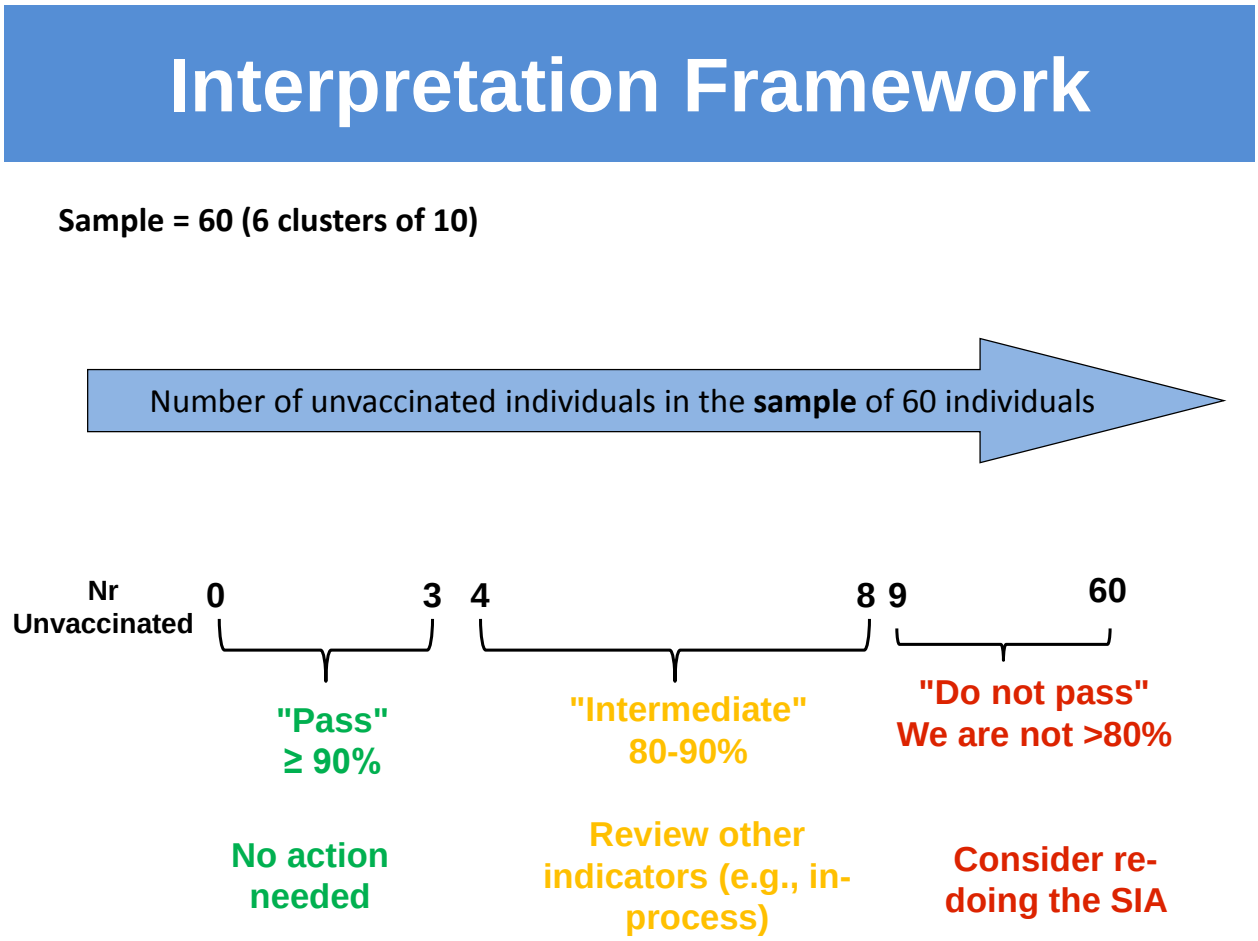
Decision rule and corrective actions are as follows:

1. 0-3 unvaccinated (out of 60): coverage is in the Higher Band (i.e. some evidence that coverage may be reaching 90%) → **PASS**
   a) *Decision:* data do not suggest performance gaps.
   b) *Recommended action:* No action needed.

2. 4-8 unvaccinated (out of 60): coverage is probably in the Medium Band (i.e. probably between 80 and 90%)→ **WARNING**
   a) *Decision:* data suggest performance gaps, though these may not be highest priority if there are areas of greater concern.
   b) *Recommended action:* review other indicators (e.g. in-process monitoring or administrative coverage) in order to decide how to increase coverage levels above 90% in the lot.

3. Nine or more unvaccinated (out of 60): coverage is probably in the Lower Band (i.e. we lack strong evidence that it is above 80%) → **FAIL**
   a) *Decision:* data suggest serious performance gaps – these areas should be given highest priority in the short term.
   b) *Recommended action:* consider re-doing the SIA (entire lot or selected areas, based on other indicators).

Figure II.3 The interpretation framework recommended by the GPEI



Additional thresholds

The GPEI recognizes that in some areas vaccination coverage is consistently very low (most lots would "fail" in the classification above). For programmatic reasons, an additional threshold (19 out of 60) may be applied to identify areas with highest priority (i.e. 20 or more children are missed in the sample of 60). This means we lack strong evidence that it is above 60%.

Ascertaining awareness about the campaign

The approach presented in this manual is focussed mainly on assessing the quality of vaccination coverage, although LQAS can be used with any dichotomous variable.

In parallel to vaccination activities, intensified communication and social mobilization activities take place in high-risk areas prior to the immunization campaign. LQAS could then also be used to assess the quality of communication activities using the same framework.

In order to do so the awareness variable should be coded as a dichotomous variable (i.e. as a yes/no question such as "were you aware of the vaccination campaign?"). In this sense, *any caregiver interviewed who indicates that she or he was not aware of the campaign prior to the arrival of the vaccination teams should be considered as a "failure" (i.e. not aware).*

In this case we will use only one of the decision rules, classifying the lots as follows:

Decision rule and corrective actions:

1. 0-3 not aware (out of 60): some evidence that awareness may be reaching 90% → **PASS**
   a) *Decision:* data do not suggest performance gaps.
   b) *Recommended action:* No action needed.
2. 4 or more not aware (out of 60): we can not be confident that awareness is above 90%→ **FAIL**

a) *Decision:* data suggest performance gaps in the communication campaign, though these may not be highest priority if there are areas of greater concern.
a) *Recommended action:* consider a different communication strategy.

Phase II - Conducting the Survey[3]

Following a strict multi-stage sampling frame is crucial in ensuring the quality of the LQAS survey.
As a general rule, to obtain the individual to be surveyed randomly (i.e. give to all eligible individuals in the lot equal chance to be in the sample) level one will have to perform a series of random selections from the clusters, which may contain more than one locality; to the compound, which may contain more than one house; to the families in the house, which may be from a different mother; to the children from this mother.

Conducting a clustered-LQAS survey involves different stages:

1) First stage: Selecting the six clusters in the lot;
2) Second stage: Selecting the 10 households in the cluster;
3) Third stage: Selecting 1 child per household.

NB: Clusters (e.g., settlements) are normally pre-selected by the "coordination team". Operationally, therefore, users will have to go to the selected clusters and focus on the second and third stages.

Sampling clusters in the lot (First stage)

In the first stage, the population is divided into a set of non-overlapping zones from which clusters will be drawn, and then the required number of clusters is sampled.

The recommended method to select clusters is sampling with probability proportionate to the size (PPS):
This procedure gives a higher probability to the largest localities to be selected as clusters, and ensures that the cluster-sample is representative of the lot.

NB: PPS only works if a list of the localities with census information is available. If this list is not available, other methods (mentioned in the annex "PPS and other methods of sampling") can be considered. In such cases, alternative sampling methods should be clearly defined and indicated in the report.

Sampling households in the cluster (Second stage)

In the second stage of sampling, users will have to select the households in each cluster. In the selected household, surveyors will administer the survey only to one eligible individual selected randomly. In the methods used in GPEI, surveyors select 10 households per cluster.

Depending on the country where the assessment is performed a household can be defined as:

- A group of people who share the same kitchen;
- A group of people whose sustainment is provided by the same person(s);
- A group of children with the same mother;
- A group of children with the same father.

Selection of the first household in the cluster:
If the lot subdivision from which a cluster will be drawn comprises more than one locality (village or neighbourhood) one will be selected randomly by simple balloting. The surveyors will proceed to the selected locality. If a map of the locality is not readily available, surveyors are advised to draft one (figure IV.2). Using identifiable landmarks (roads, rivers, etc.) on the map they will divide the locality into four

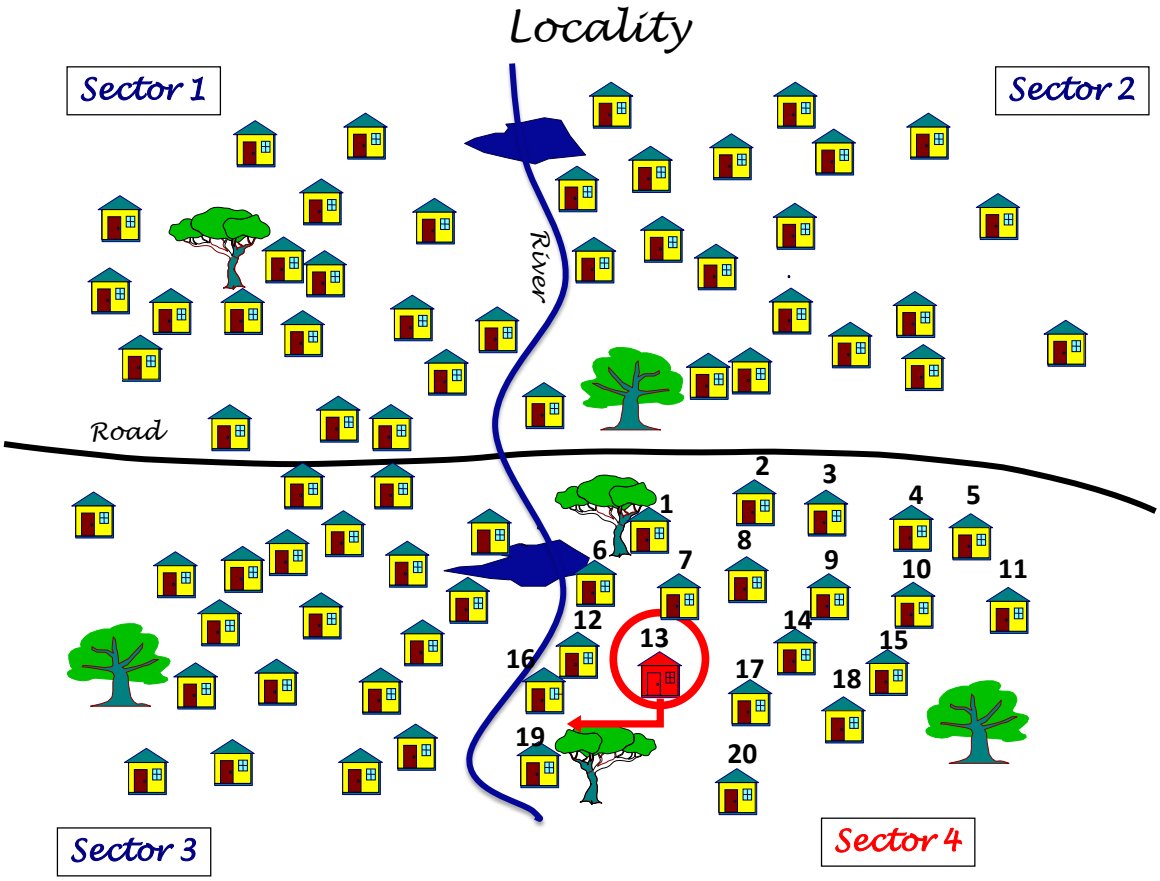
[3] We describe the sampling procedure based on the fixed sample size of 60 children aged from 0 to 59 months divided in six clusters of 10 children.

sectors of approximately equal population size. They will select one sector randomly. They will go to the selected sector (figure IV.1).

Sectors of 20 households or fewer:
If the number of households in the sector is 20 or fewer, surveyors will number them and randomly select one to be the starting point of the survey.

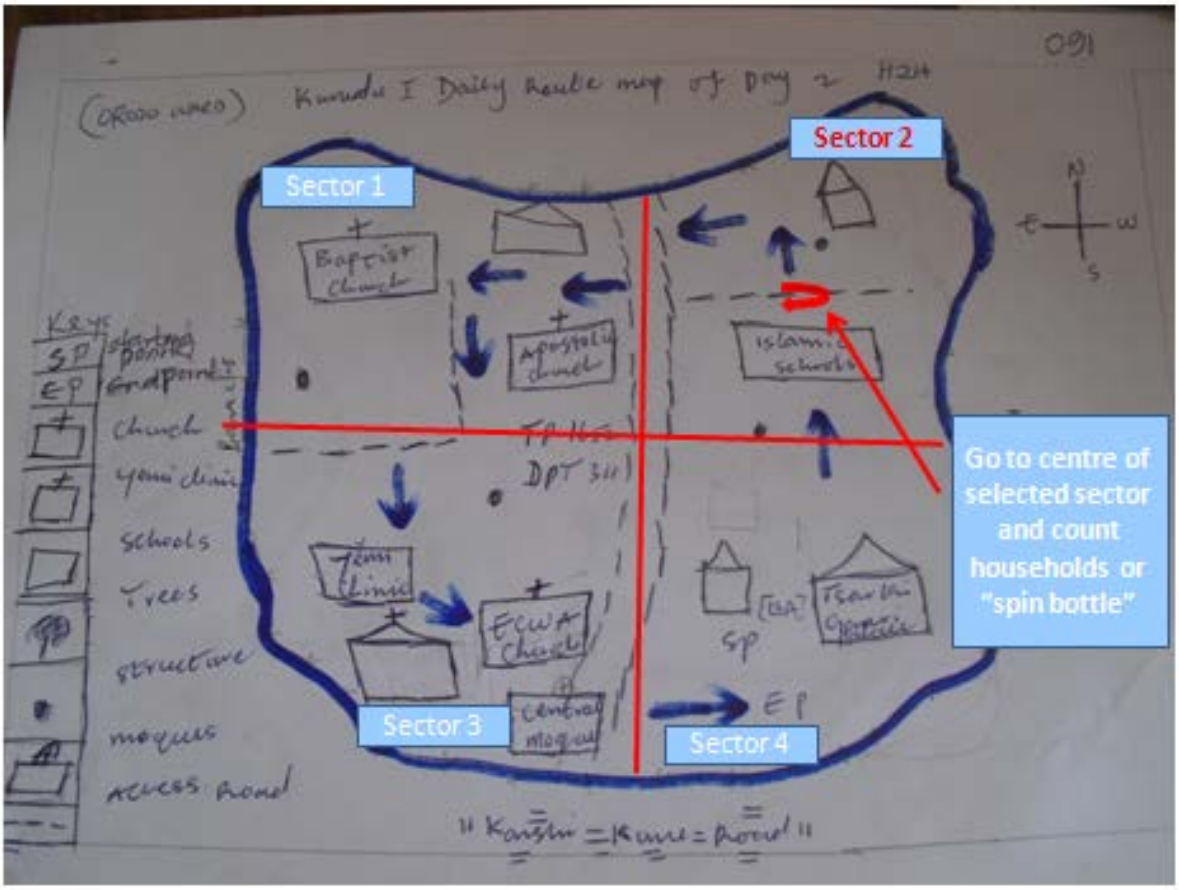
Sectors of more than 20 households:
If there are more than 20 households in the sector, the surveyors will divide the sector into four smaller sectors of equal size and randomly select one, according to the procedure described above, and repeat this procedure until they obtain a sector with 20 or fewer households. If this is not feasible (i.e. a map is not available or the field conditions prevent one being sketched on site), the surveyors will go to the centre of the sector and use the "spin-the-bottle" procedure.

Figure II.4 Selection of the first household to survey in a village/neighbourhood



Example: The surveyors divided the locality in four sectors of approximately 20 or fewer households using the available landmarks (a river and a road); they randomly selected Sector 4; they numbered all the households in that sector and randomly selected Household 13 as the starting point of the survey.

Figure II.5 Example of a sketch drawn to select the first household in a village/neighbourhood with more than 20 houses



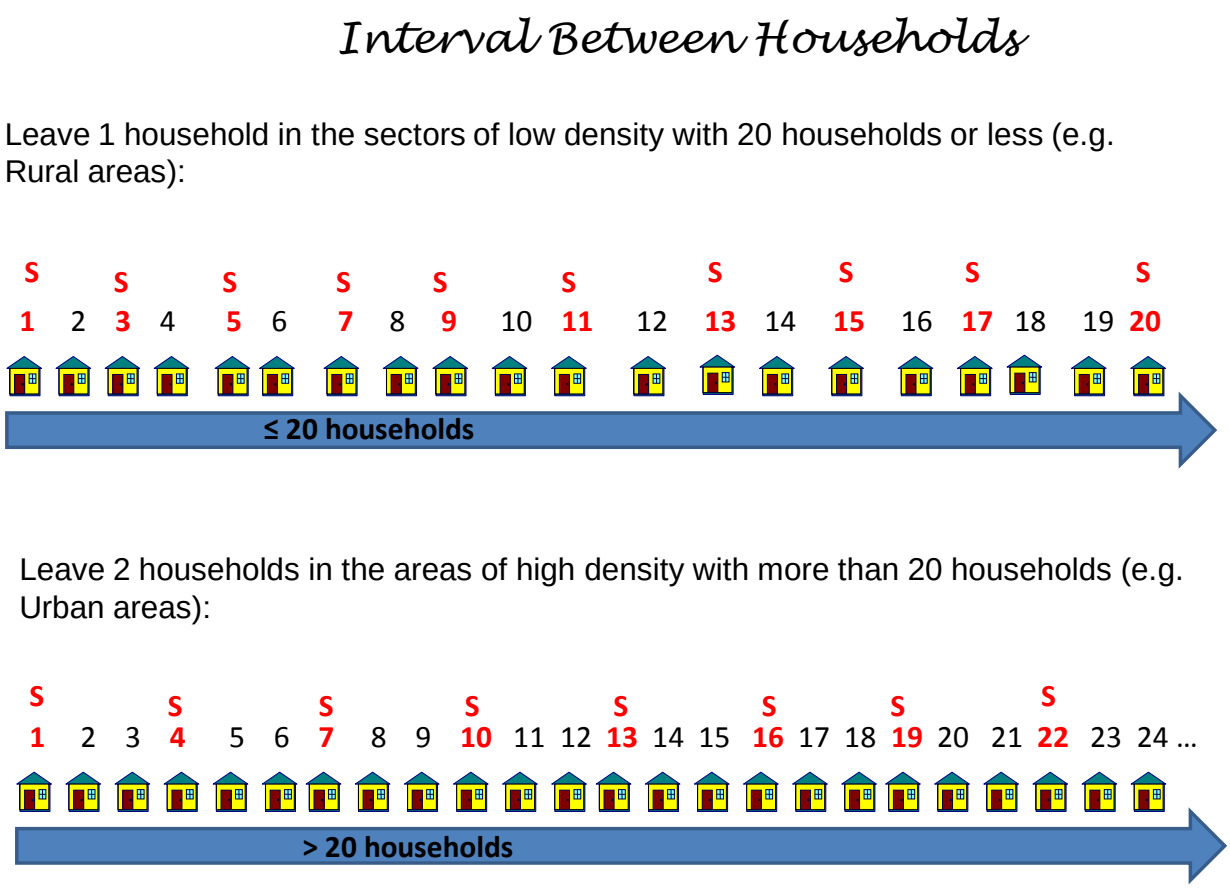
Selection of the nine following households in the survey

To ensure that the sample is spread across the entire locality, households immediately next to each other in the cluster should not be selected. Once surveyors have visited the first household, they should continue with the survey by exiting the door to their right and selecting the nine subsequent households, leaving a predetermined interval between them (Figure IV.3).

This interval depends on the size of the settlement:

- *≤ 20 households:* turn to the right and leave one household between each selected household
- *>20 households:* turn to the right and leave two households between each selected household

Figure III.6 Procedure to select the following households in a village/neighbourhood



If, while following this procedure, surveyors end up in a different sector of the map from the one where they have selected the first household, it is not a problem as long as they remain in the same locality (village or neighbourhood) chosen for the cluster. If they have walked the entire locality without interviewing all the participants required for the cluster, they then should go to the next nearest locality (village or neighbourhood) in the same lot to complete the survey for that cluster.

Sampling one child per household (Third stage)

Only one child between 0 and 59 months should be selected randomly per household to respond to the survey. To ensure that the participant in the house is selected randomly, all children present in the house eligible for the vaccine should be numbered and one selected using a random ballot (see Table of Random Numbers in Annex I).

The surveyors will ask an adult to answer the questions on his/her behalf. If no adults are present in the house, they will move on to the neighbouring one to the right. If in the selected household there are no eligible individuals they will also go to the neighbouring house to the right.

Data collection

Questionnaires

The LQAS questionnaires list the questions to be asked in each household and provide space to record information about the individuals interviewed. The main variable of interest for this survey will be the presence/absence of the finger mark on the nail of the child selected (see Questionnaire in Annex I).
In addition to paper questionnaires, where available, mobile phones can also be used for data collection and transmission of results to ensure real-time analysis and avoid intentional and unintentional errors[4].

Summary sheets

Summary sheets may also be useful for analyzing and reporting data, where the number of vaccinated and unvaccinated individuals is recorded for each cluster in the lot.
Examples of LQ questionnaires and Summary Forms are available in ANNEX I – Tools for data collection.

Taking action

Once the survey is completed and 60 individuals are sampled action can now be taken according to the framework (see Phase II – Choosing the clustered-LQAS framework) that has been chosen for use.

[4] WHO has developed a technology (Episurveyor) that allows conducting a Clustered - LQAS survey using mobile phones (see separate WHO manual "Setting up a Clustered - LQAS Survey Using Mobile Phones", George Walker, August 30 2010)

What if…

In following this procedure you may encounter conditions that vary slightly from what is planned. This is not a problem as long as you decide beforehand how to treat unusual situations in a standard way.
Examples of unusual situations:

a) *The building selected is a religious or commercial building, an office, shop, or school*. Do not administer the survey. Go to the neighbouring household in the agreed direction (e.g. to your right), without leaving an interval.
b) *There are buildings with more than one household (e.g. apartment blocks in urban centres).* You will have to select one household randomly in the building following a stepwise approach. Select one floor randomly, then on the selected floor select one apartment randomly. To avoid clustering all the individuals in one building, once a household is selected, leave the building and return to the street, and follow the sampling interval to the right.
c) *The household selected is empty.* Go to the next neighbouring household in the agreed direction without leaving an interval.
d) *There are only children in the household.* Go to the next neighbouring household in the agreed direction without leaving the interval.
e) *There is nothing to your right when you exit the house.* In this case turn to your right until you face a direction where you see households.
f) *In turning to your right and following the procedure you reach a wall or a physical barrier.* You will have to turn to your right on site until you face a direction where you see households.
g) *In turning to your right and following the procedure you end up covering the same area that you have already covered.* You will have to ignore this area and proceed to the closest area that you have not yet covered. If all the locality has been covered, consider moving to the closest locality in the same lot (see point i) below)
h) *You reach the dead end of the road (i.e. there are no other roads to your side).* You will have to turn approximately 180° to the right and proceed on the other side of the road (e.g. the left side of the road if you were on the right side).
i) *In following the procedure you are not able to complete the interviews because there are not enough households or target individuals in the locality.* Go to the geographically closest locality (village or neighbourhood) in the same lot to continue the interviews and complete the cluster. Select the first household of the locality and the subsequent ones according to the same procedure described.
j) *You find children who are not permanent residents of the house (e.g. visitors).* They should be included if they were eligible to receive the vaccine (aged between 0-59 months living in an area targeted by the SIA).

Summary of sampling procedure (six clusters of 10)

1) First Stage	
a)	Six clusters per lot will be pre-selected by the survey coordination team using PPS.
b)	Select one locality randomly in each of the six cluster areas.
c)	Go to the selected locality.
2) Second Stage	
a)	Divide the locality in four sectors using an available map, or sketch one identifying some landmarks (e.g. road, river, school, mosque, church, etc.).
b)	Select one sector randomly and go to the selected sector.
c)	If the sector has maximum 20 households (HHs), number them and select one randomly as the starting point of the survey.
d)	If the sector has more than 20 HHs, repeat steps a-c.
e)	Administer the survey in the HH selected as the starting point.
f)	Once the survey is completed in the selected HH, turn right exiting the house and select the following HHs to survey according to the predetermined interval.
g)	Complete the survey of 10 children in the selected cluster and move to the following one. If completing an LQAS for more than one vaccine, complete the survey with 10 eligible individuals for each vaccine.
3) Third Stage: Selecting one child per household	
a)	In each household one child should be randomly selected to respond to the survey.
b)	List and number all the children from 0-59 years of age living in the household.
c)	Select one child randomly from the list using the table of random numbers.
d)	The survey in the lot is completed once 60 children per lot are surveyed (six clusters; 10 children per cluster).

Communicating results and taking action

Especially if we are in the FAIL or WARNING bands, it is very important to forward this information immediately to decision-makers and interested stakeholders so that measures to raise vaccination coverage can be rapidly implemented at lot level. You will need to consider what may have caused the low coverage identified in the rejected lots (e.g. absence of immunization cards rather than vaccine, not enough vaccine vials in that area, presence of hard-to reach areas, etc.) and then design solutions accordingly.

What if the lot PASSES?

Clustered-LQAS may also show that vaccination coverage is higher than expected in certain lots, meaning that the classification is: PASS. If the lots thought to have low coverage are actually doing well, users may want to consider redirecting resources to areas more in need. This decision needs to be taken carefully however, making sure that the workforce is not removed from areas that still need it.

Chapter III - Composition of the survey teams and responsibilities

Ideally the survey should be conducted by independent survey personnel not involved in vaccination activities. If this is not possible then teams who have vaccinated in one area could be deployed to evaluate coverage in another one.
In order to complete a clustered-LQAS survey successfully, the following human resources should be identified and recruited:

1) Coordinators
2) Supervisors
3) Surveyors
4) Local guides

Coordinators

The professionals involved in protocol writing and planning the survey (e.g. local WHO staff, international WHO staff, or consultants) can act as survey coordinators making sure that the teams can cover all the territory. The LQAS coordinator is the person in charge of the survey (from recruiting the human resources, coordinating the training and the implementation, interpreting the results). Coordinators are also responsible for ensuring overall quality of the survey (i.e. quality in training, in data collection, in data entry, etc.). The coordinator is also responsible for writing the final report of the survey.

Supervisors

At state/province level, supervisors should be nominated to ensure the quality of LQAS. The supervisor officer should support introduction, monitor the quality of LQAS and corrective actions.

Two "Supervision scenarios" are normally considered for LQAS surveys:

1) The survey is supervised by local WHO staff.
2) The survey is supervised by other independent partners, such as NGOs, sub-contractors, universities, etc.

Where possible:

- Employ experienced staff from WHO, UNICEF and international partners as supervisors.
- Outsource the task to external organizations only when similar quality of staff can be provided.
- Staff involved in vaccination activities (i.e. local ministry of health staff) should not be involved in the coordination of the survey.

Surveyors

Depending on the number of lots, their geographical size, the timing of the evaluation and conditions in the field, the coordinators will determine the number of surveyors needed for each lot. A team of two surveyors may be able to cover a lot (e.g. completing six clusters) in two days if provided with a vehicle but this may not be the case depending on resources available and on the country.

Responsibilities of surveyors:

1) Visiting the household and administering the questionnaire.
2) Should be knowledgeable about the territory that they need to cover.
3) Should be very familiar with the customs and culture of the people living in the area.
4) Should speak the local language.

Surveyors work efficiently in teams of two, ideally a man and a woman. In some areas, where men are not allowed in the households, only female surveyors in your workforce may be preferred.

To ensure independence of surveyors from vaccination activities they should:

1) Be deployed to locations outside their daily responsibility.
2) Regularly change the areas that they assess (e.g., different provinces after different rounds).

Local guides

In some cases, local guides may be recruited to support the surveyors with data collection in territories with which there are unfamiliar.

Chapter IV – Training

Clustered-LQAS field survey manual

A survey manual has to be prepared so that the survey teams know what to do once they are in the field. Based on what was discussed above on the sampling plan and on the sampling frame, the manual will include instructions on:

1. Introduction to the study and the objectives.
2. How to choose sampling points.
3. How to choose one target individual in each household.
4. How to administer the questionnaire.
5. Who to contact while in the field.
6. To whom to communicate the decision in order for actions to be taken.

Training workshop

Before starting data collection, the surveyors will need a training session (workshop) of one or two days on data collection, reporting the findings, and decision-making if necessary. The training should combine theoretical and practical activities. You will need to present the information contained in the manual to the survey teams during this workshop to make sure that everybody understands the purpose and objectives of the survey.

The training workshop should include the following activities:

1. An overview of the survey, its purpose, how it will be carried out, and how the data will be used.
2. Review of instructions, with examples of hypothetical problems that data collectors might encounter.
3. Review of data collection forms, their purpose and content, and practice in completing them with hypothetical information.
4. A practice session in the field (select an area near to where the training is taking place) so that surveyors understand how to select random starting points and individuals in the cluster. This session should last up to half a day, leaving time to discuss any problems encountered in the field in order to adapt the survey manual. During the field practice exercise, each surveyor should do a few samplings themselves
5. Written examination (short quiz) and group discussion of the results to make sure that everybody has understood what to do in the field

If the conduction of the survey is outsourced to an external organization, WHO/UNICEF staff should still make sure to attend to ensure quality.

Checklist before going to the field

It is important to ensure that everybody will travel to the lots well-prepared after the workshop. You need to make sure that survey teams bring with them to the field the following tools:

1. *Personal identification* – they should always be able to demonstrate who they are and why they are there to the interviewees.
2. *Survey manual* – for reference in the field.
3. *List of the localities (clusters) in the lot to survey* – if it is not possible at central level to pre-select the clusters where the survey will take place, then the surveying teams will need to select the six clusters once they are in the lot with the help of local public health officials.
4. *Maps of the localities to survey:* if maps of the localities (clusters) of the lots are available in advance, it may be helpful to hand them to the surveying teams during training; if they are not available they will have to draft them on site.

5. *Table of random numbers:* to allow random selection of sectors in a village (or settlement) with more than 20 households, individuals, etc.
6. *Notepad and pen:* to take notes, draft the map of the locality if needed, complete the questionnaires, etc.
7. *Questionnaires:* carry some spare copies in case the questionnaires get lost or damaged during travelling.
8. *Summary sheet:* also carry some spare copies in case the questionnaires get lost or damaged during travelling.
9. *Survey contact sheet:* to know who to contact during the survey, especially if a decision is taken in their lot.

Supervisor/coordinator's check-list: Best practices to ensure quality during the stages of Clustered-LQAS

Stage	Best practice
Selection of surveyors	• Employ experienced staff from WHO, UNICEF and partners. • Outsource the task only when the organization can provide the similar quality of staff.
Deployment of surveyors	• A surveyor should be deployed to locations outside his/her responsibility. • A surveyor should regularly change geography (e.g., different provinces).
Training	• The training of surveyors should include both theory and field practice. • During field practice, each surveyor should do a few samplings personally. • If outsourced, WHO/UNICEF staff should attend the training to assure the quality of training and surveyor.
Methodology	• Lots and clusters (e.g., settlements) should be pre-selected. • Surveyors should follow the pre-determined house selection methods (e.g. random starting points, skip one/two houses, one child per house). • Use mobile phones to transmit results to ensure real-time analysis and avoid intentional and unintentional errors.
Quality assurance	• The dedicated officer should support introduction, monitor the quality of LQAS and corrective actions (e.g. "refresher course"). • Supervisors should be nominated at state/province level to ensure the quality of LQAS.

ANNEXES

ANNEX I – Tools for data collection

Example of questionnaire

Q1: Lot: _____
Q2: Cluster Number: **|__| (1-6)**
Q3: Name of the locality for the cluster (village/neighbourhood): _____
Q4: Name of Surveyor: _____ Signature: _____
Q5: Name of LQAS Supervisor: _____ Signature: _____
Q6: Date: **|__|__| |__|__| |__|__|**

Vaccination Status

Note: Only administer the questionnaire to one eligible child randomly selected per household.

Progressive number of household in the cluster		1	2	3	4	5	6	7	8	9	10
Q7: Age	In months; if above 59 months do not administer questionnaire.										
Q8: Sex	M=Male F=Female										
Q9: Vaccinated (Presenting "finger mark")	Y=Yes/ N=No										
Q10: Was caregiver aware of the polio vaccination campaign prior to the arrival of the vaccination teams?	Y=Yes/ N=No										

Q11:Comments_____ _____ _____ _____

_____ _____ _____

Example of LQ Summary Sheet

Lot: _____
Lot Number |__|__|

Date: |__|__| |__|__| |__|__|

_____

Cluster Number	1	2	3	4	5	6	Total	
	Number of unvaccinated individuals							
OPV	/10	/10	/10	/10	/10	/10	/60	

Supervisor's Name _____

Signature _____

Supervisor's Comments:

_____
_____
_____
_____
_____

Table of Random Numbers

	1	2	3	4	5	6	7	8	9	10
1	77937	36192	73719	60892	88731	53312	32028	51981	52537	13792
2	62235	21784	63671	43307	27466	18725	30422	35364	22684	52940
3	41271	76943	63176	13983	76307	62649	37776	12373	27781	08448
4	74303	91599	18364	46854	55978	16696	70329	57342	75565	00195
5	07316	19966	36871	69972	41876	23919	35358	75206	83106	28462
6	19852	18979	14669	67059	35079	08989	18634	09736	58087	87453
7	44332	63036	51047	22662	60949	48177	87131	42936	06018	88193
8	18139	72389	49388	72664	65670	32657	86661	42756	64465	74816
9	98592	49059	95525	38095	08437	30024	94906	62951	94659	99819
10	40317	53391	41926	35351	85078	18072	83048	66366	05390	35376
11	62617	66075	30313	97008	78976	48652	17317	30662	60683	12054
12	16911	00422	55292	25757	16504	54582	26375	63502	80040	47941
13	68800	73988	76322	65662	32778	52376	57512	01105	12160	04995
14	33682	48961	58841	56325	66879	50433	88774	35632	71408	54487
15	97012	25698	43344	64489	03461	18996	46699	19042	54195	66669
16	67003	86784	64254	00365	22206	18449	34569	21006	96242	43069
17	67427	02409	32424	44517	56795	34543	64366	75534	39516	73236
18	97145	24129	53570	90142	99015	49437	47618	72842	85020	87873
19	34107	47747	76070	23154	82296	09290	04927	86570	62716	08756
20	79935	12969	28375	73660	47982	35603	21854	79458	12409	73075
21	66851	75572	70463	06772	67840	78904	85099	32362	44651	02838
22	38961	69197	82905	14125	96240	91644	41386	60459	27086	52120
23	31328	87208	59649	65047	80656	78864	76109	56510	67849	87587
24	78168	43077	30959	32122	54398	63458	97905	46236	11563	80304
25	17222	23833	35686	54720	09829	69955	61885	99788	77326	64731
26	45809	63139	81163	05649	00363	63170	26216	90827	61389	25389
27	26642	59445	25983	42847	57804	61654	46982	60754	34006	38567
28	68226	89572	26090	42023	00666	02597	25822	62540	71707	19298
29	48979	17044	65889	64133	20822	85760	58584	19169	91751	64343
30	24232	43444	96175	44077	81707	67092	33498	62705	55320	81586
31	53817	64027	76885	41107	73940	69311	46040	63937	56902	76517
32	93054	93155	10300	55402	00309	33606	91680	20765	47442	59969
33	29728	00073	59085	02873	48760	30478	11427	50241	18561	66696
34	34274	00724	31564	07996	72888	68474	68155	36174	51775	37193
35	60390	31910	78978	68916	64532	48340	40781	01328	93294	07851
36	07382	67510	09460	52079	50167	06148	07958	91373	79428	27265
37	72224	70340	26434	35730	18762	64542	36808	47245	55879	84712
38	75554	03456	23941	11799	99878	45542	75357	98517	76468	13305
39	57986	93186	48996	59792	84119	27347	10041	55929	71798	54654
40	76008	32565	17101	78443	01274	04465	53071	85576	59024	61211

How to use the table of random numbers

The table of random numbers is a list of randomly-selected numbers. To select a number randomly, you need to know how many households are included in your village/sector and how many digits this total number of households has. For example, if the surveyor needs to select randomly a household in a village, he or she first needs to number all households in the sector between *1* and *n*, where *n* is the total number of households in the sector.

For example, let us say that the surveyors are in a sector with 20 households and have to select one randomly as the starting point of the survey. They number all the households from 1 to 20. Twenty is a two digit number so they will have to choose randomly from the table the first number with two digits between 1 and 20. They point with the pen to a random spot on the table (one way to do it is to place a finger on the table without looking at it before). From this spot, move your finger towards the right until you find the first 2-digit number between 01 and 20. The household allocated this number will be the one selected to start the survey.

Look at the table. Let us say that the number 8 from the cell 87131 (row 7 column 7) has been pointed to. Move to the right and look at every 2-digit number in the table. This produces the following numbers: 87, 71, 13, 31, 14, 42... Hence, 13 is the first 2-digit number between 1 and 20 screened. Consequently, the randomly selected household for this sector will be number 13.

ANNEX II - Budget and logistic arrangements

The clustered-LQAS survey is a rapid survey characterized by its small sample size, rapidity of implementation, ease of interpretation, and consequent low cost compared to a fully-fledged survey.
The budget needed to conduct a clustered-LQAS survey may vary depending on the country of study, on the extent of the survey, and on resources available.

When budgeting for an LQAS survey, users may want to consider the following expenses:

1. Administrative costs
    a. Planning the study.
    b. Recruiting the surveyors.
    c. Data entry (if needed).
    d. Report writing.
2. Training days
    a. Per diem for trainers.
    b. Per diem for trainees.
    c. Lunch and coffee breaks.
3. Tools
    a. Pens.
    b. Notebooks.
    c. Mobile phones.
    d. Laptops.
4. Printing materials
    a. Training manual.
    b. Data collection forms.
    c. Personal identification.
5. Human resources during the survey
    a. Per diem for supervisors.
    b. Per diem for surveyors.
    c. Compensation for local guides.
6. Travel costs
    a. Vehicles.
    b. Public transport.
7. Communication costs
    a. Mobile phone credit.

ANNEX III – PPS and other methods of sampling

Sampling with probability proportionate to the size (PPS)

If a list of the localities with census information is available in the lot you can consider using PPS to select clusters. This procedure gives a higher probability to the largest localities to be selected as clusters. Depending on how the vaccination campaign is organized, larger localities may also have a higher chance of being reached by vaccination activities than smaller ones. Conducting the survey in such localities may not be what users want if they are seeking to ensure that every locality has the same chance of being selected in the sample.

Steps to conduct PPS sampling:

1) *List all villages with population size and the cumulative population in a sheet of paper.*
2) *Calculate the sampling interval.* To do this you must divide the total population of the district by the number of clusters you want to select.
3) *Choose a random number between 0 and the sampling interval using the table of random numbers.*
4) *Write down the random number on the sheet of paper.* The first cluster will be sampled in the village where the cumulative population number contains the random number.
5) *Add the sampling interval to the random number.* The second cluster will be selected in the village where the cumulative population number contains the random number.
6) *The following clusters will be selected by adding the sampling interval to the previous number progressively.* Each time we will retain the village where this progressive number is contained in the cumulative population.
7) *Follow the process until you know in which villages you will select the clusters needed.*

As this sampling technique is proportional to the size of the villages, large villages will have a greater probability than small villages of being in the sample, and very large villages may have more than one cluster.

Example of PPS sampling
In this example for a health sub-district with a population of 5841, we plan to select 5 villages in each of which 10 individuals will be interviewed.
The surveyors compiled the sheet below.

Sheet to select the villages in the health district according to PPS
Number of clusters needed: *5*
Cumulative population of the health district: *5841*
Sampling interval: 5841/5= 1168
Random number (between 1 and the sampling interval): *661*

1. Village No.	2. Village Name	3. Village Population	4. Cumulative Population	5. No of clusters selected in the village	6. Progressive Sampling Number
1	A	246	246		
2	**B**	1577	1823		**661***
3	**C**	468	2291		**1829****
4	D	340	2631		
5	E	220	2851		
6	**F**	246	3097		**2997*****
7	G	190	3287		
8	**H**	1124	4411		**4165********
9	I	61	4472		
10	J	154	4626		
11	K	139	4765		
12	L	60	4825		
13	M	14	4839		
14	N	38	4877		
15	O	19	4896		
16	P	41	4937		
17	Q	120	5057		
18	**R**	455	5512		**5333**
19	S	51	5563		
20	T	26	5589		
21	U	199	5788		
22	V	21	5809		
23	W	32	5841		

*Random number; **progressive number 1829 (random number 661 + sampling interval 1168); *** progressive number 2997 (previous progressive number 1829 + sampling interval 1168); **** etc.

According to this procedure the five villages selected to sample 10 individuals will be: B, C, F, H, and R.

Other Methods

In case PPS is not viable (e.g. you do not have a list of localities with population data) you can consider other methods to sample clusters in the lot.

Simple random sampling (SRS)

For SRS you just need to have the list of all localities in the lot and you will select the number needed by simple random ballot. The advantage of SRS is that it does not require census information. SRS will give the

same chance to every locality to be selected, although the chance of each child being selected will depend on the locality. This results in a sample that is less representative of the entire lot.

Geographical sampling methods

If maps of the area considered as a lot are available, you may opt for geographical sampling methods, such as centric systematic area sampling (CSAS), to ensure that the probability of being selected as cluster is evenly spread across the whole territory. The CSAS method involves dividing the survey area (lot) into a grid of non-overlapping numbered squares of equal size (quadrants), selecting randomly the quadrants from which we will select one cluster each, and sampling the community located closest to the centre of each quadrant [4].

NB: We discourage the use of these methods because they produce a sample that is not representative of the entire lot. They should only be used when sampling with PPS is not possible.

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